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PATENT SPECIFICATION

776,416

Inventor: ALBERT WILLIAM BAMFORTH

Date of Application and filing Complete Specification: July 20, 1955.

No. 20955/55.

Complete Specification Published: June 5, 1957.

Index at acceptance:—Classes 32, B3A; and 64(3), S10.

International Classification:—B01d. F25h.

COMPLETE SPECIFICATION

CORRECTION OF CLERICAL ERROR

SPECIFICATION NO. 776,416

The following correction is in accordance with the Decision of the Assistant Comptroller, acting for the Comptroller-General, dated the twentyninth day of July, 1957.

Page 1, the name of the Inventor *should read* "Alfred William Bamforth".

THE PATENT OFFICE,
4th September, 1957

DB 63168/1(13)/3744 100 8/57 R

so that a saturated solution of a solid of normal solubility is cooled, or a saturated solution of a solid of revert solubility is heated, to such an extent that the solution leaving the heat exchanger becomes supersaturated in the metastable field, in which field crystals do not form spontaneously and little or no crystal formation takes place in the heat exchanger. If at any point in the heat exchanger the supersaturated solution of a solid of normal solubility is further cooled, or the supersaturated solution of a solid of revert solubility is further heated, the solution may become supersaturated in the labile field, in which field crystals form spontaneously and crystals can be deposited on metal surfaces in the heat exchanger.

In the usual form of construction of tubular heat exchangers metal tubes are expanded into metal tube plates and the shell is either welded to the tube plates or provided with flanges which are attached to the tube plates by means of bolts or studs. Inlet and outlet solution connecting pipes are either welded or bolted to the tube plates. In operation, substantially stagnant zones of saturated or supersaturated solution occur in the inlet and outlet connecting

[Price ~~3s. 6d.~~]

the inside of the tubes in the tube plates, causing blockage of the tubes.

To overcome the deposition of crystals on the tube plates and inside the tubes it has been proposed to attach a layer of rubber or like material to the face of the tube plate which is in contact with the cooling or heating medium. The layer of rubber or like material is attached to the tube plate so that it closely fits into the shell and is drilled with tube holes concentric with the tube holes of the tube plate. The tube plates are then attached to the shell, usually by bolts to a flanged shell, and the tubes are then expanded into the tube plates in the usual manner. The layer of rubber or like material insulates the metal tube plate from contact with the cooling or heating medium and due to the low thermal conductivity of the material the metal temperature of the tube plates, and thus also of the ends of the tubes in contact with the tube plate, is substantially the same as the temperature of solution entering or leaving the tubes. Consequently the stagnant zones of solution at the tube plates do not tend to become supersaturated in the labile field and little or no crystal formation takes place on the tube plates, or inside the tubes.

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COMPLETE SPECIFICATION

Improvements in or relating to Tubular Heat Exchangers

We, THE POWER-GAS CORPORATION LIMITED, a British Company, of Parkfield Works, Stockton-on-Tees, County Durham, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to tubular heat exchangers and more particularly to a method of insulating a tube plate of a multi-tubular heat exchanger. It is especially applicable to heat exchangers of the type which are employed for cooling or heating solutions which are saturated or slightly supersaturated with crystallizable solids. With these the saturated solution is passed through the tubes while a cooling medium, such as water, or a heating medium, such as steam, is passed in the shell outside the tubes.

Heat exchangers are often designed to operate so that a saturated solution of a solid of normal solubility is cooled, or a saturated solution of a solid of revert solubility is heated, to such an extent that the solution leaving the heat exchanger becomes supersaturated in the metastable field, in which field crystals do not form spontaneously and little or no crystal formation takes place in the heat exchanger. If at any point in the heat exchanger the supersaturated solution of a solid of normal solubility is further cooled, or the supersaturated solution of a solid of revert solubility is further heated, the solution may become supersaturated in the labile field, in which field crystals form spontaneously and crystals can be deposited on metal surfaces in the heat exchanger.

In the usual form of construction of tubular heat exchangers metal tubes are expanded into metal tube plates and the shell is either welded to the tube plates or provided with flanges which are attached to the tube plates by means of bolts or studs. Inlet and outlet solution connecting pipes are either welded or bolted to the tube plates. In operation, substantially stagnant zones of saturated or supersaturated solution occur in the inlet and outlet connecting pipes at the tube plate, between the tubes, and between the tube plates and their corresponding connecting pipes. As the tube plates are in contact with the cooling or heating medium the metal temperature of the tube plates can be considerably lower than the temperature of the solution entering or leaving the tubes when a cooling medium is used or considerably higher than the solution temperature when a heating medium is used. Consequently, the stagnant zones of saturated or supersaturated solution at the tube plates become cooled or heated to such an extent that the solution becomes supersaturated in the labile field and crystals are deposited on the tube plates. The metal temperature of the tubes in contact with the tube plates is substantially the same as the metal temperature of the tube plates, thus the crystals which are deposited on the tube plates tend to grow and further crystals become deposited on the inside of the tubes in the tube plates, causing blockage of the tubes.

To overcome the deposition of crystals on the tube plates and inside the tubes it has been proposed to attach a layer of rubber or like material to the face of the tube plate which is in contact with the cooling or heating medium. The layer of rubber or like material is attached to the tube plate so that it closely fits into the shell and is drilled with tube holes concentric with the tube holes of the tube plate. The tube plates are then attached to the shell, usually by bolts to a flanged shell, and the tubes are then expanded into the tube plates in the usual manner. The layer of rubber or like material insulates the metal tube plate from contact with the cooling or heating medium and due to the low thermal conductivity of the material the metal temperature of the tube plates, and thus also of the ends of the tubes in contact with the tube plate, is substantially the same as the temperature of solution entering or leaving the tubes. Consequently the stagnant zones of solution at the tube plates do not tend to become supersaturated in the labile field and little or no crystal formation takes place on the tube plates, or inside the tubes.

[*Price* ~~2s. 6d.~~]

The object of the present invention is to provide an improved method of insulating the tube plates from contact with the cooling or heating medium within the shell of the heat exchanger and hence to minimise or prevent the depositing of crystals on the tube plates or inside the tubes.

According to the present invention a method of insulating a tube plate of a multi-tubular heat exchanger having a shell surrounding the tubes comprises steps of positioning the exchanger to bring said tube plate lowermost and substantially horizontal, pouring a settable heat insulating material through an aperture in the shell of the exchanger, and thereafter allowing the material to settle and solidify with or without the application of heat as necessary, to form a heat insulating layer in contact with the tube plate and the adjacent end regions of the exchanger tubes.

Preferably the heat insulating material is introduced into the shell of the heat exchanger through an aperture normally adapted for conveying the cooling or heating medium into the shell. A measured quantity of the insulating material, calculated to give the desired thickness of insulating layer, is conveniently introduced through this aperture. Alternatively a small overflow aperture which may be closed with a screwed plug or blank flange is provided in the shell suitably disposed near to the tube plate, between the tube plate and the pouring aperture, so as to provide for the required thickness of said insulating layer. The insulating material is introduced through the pouring aperture until it commences to overflow through the overflow aperture. The overflow aperture may conveniently be disposed on the opposite side of the shell to the pouring aperture.

When one tube plate has thus been covered with a solid adhering layer of thermal insulating material the heat exchanger can be turned upside down and the other tube plate covered in a similar way.

The pourable insulating material which is allowed to settle on a tube plate and subsequently solidified into a solid layer of low thermal conductivity adhering to the tube plate and tubes may be one of several types.

One preferred type comprises a thermosetting resin in the liquid form which is hardened by the application of heat to a solid form which cannot be softened by further application of heat. A variant of this type is a mixture of a liquid thermosetting resin and an appropriate catalyst, which is added just before pouring, the hardening out of the resin takes place either with or without the application of heat. Examples of suitable thermosetting resins are the synthetic resins from phenol and formaldehyde, cresol and formaldehyde, urea and formaldehyde, melamine and formaldehyde, phenol and furfural and polyesters.

Another type comprises hot molten resin, wax, pitch or bituminous material which hardens to a solid on cooling, but may be remelted on heating. This type includes natural resins and certain synthetic resins.

A further type comprises a solution of a resin or thermoplastic material in a solvent such as acetone, amylacetate, chlorinated hydrocarbons etc. After pouring and allowing the liquid solution to settle on the tube plate, the solvent is evaporated by the application of heat, leaving a solid residue adhering to the tube plate and tubes. In addition to natural and synthetic resins thermoplastic materials such as cellulose ester, polyvinyl compounds, polystyrene, polyethylene, and natural and synthetic rubber can be so applied.

A powdered inorganic filler, such as chalk, magnesium oxide or carbonate, titanium oxide, powdered mica etc., may be incorporated in any of the above three types of pourable insulating material. The filler is intimately mixed in the liquid to a uniform suspension before pouring the liquid mass. It has been found that the incorporation of a filler reduces shrinkage when the material is solidified.

Yet another type of pourable liquid mass consists of a plaster or cement slurry, with or without the addition of aggregate. After the slurry has settled on the tube plate is it allowed to stand and harden into a solid mass. Examples of this type are, plaster of Paris, dental plaster and concrete mixtures with Portland cement or high alumina cement.

When the pourable material solidifies on the tube plate a certain amount of shrinkage usually occurs. It has been found that the solidified mass usually adheres strongly to the tube plate and tubes but that the shrinkage may result in the solid layer becoming detached from the inside surface of the shell of the heat exchanger. To ensure keying of the solid layer to the inside surface of the shell metal projections or studs are preferably welded to the inner surface of the shell at suitable circumferential intervals and close to the tube plate. These projections are immersed in the liquid material when poured and key the resultant insulating layer to the shell.

An advantage of the present invention over the known method of attaching a layer of rubber or like material to the tube plate before assembly of the heat exchanger and the expanding of the tubes into the tube plates, is that the tube plates of existing heat exchangers, particularly where the tube plates are welded to the shell, can be easily and conveniently insulated from contact with the cooling or heating medium.

Another advantage of the present invention is that a variety of materials can be applied to form the solid insulating layer, the materials being chosen according to the nature of the cooling or heating medium and its temperature.

The invention is further described, by way of example, with reference to the accompanying drawings, in which:—

Fig. 1 is a fragmentary sectional view illustrating one form of construction and assembly of a tubular heat exchanger;

Fig. 2 is a fragmentary sectional view illustrating another form of construction and assembly; and

Fig. 3 is an enlarged sectional view of a detail incorporated in Fig. 2.

Referring now to Fig. 1 of the drawing, the tubes such as 2 are expanded into the tube plate 1 which is attached to the shell 3 and connecting pipe 5 by means of flanges 4 and 6 welded to the shell and pipe respectively and bolts 7 passing through matching bolt holes in the tube plate and flanges. The connection 8 in the shell near the tube plate is provided for the entry or exit of the cooling or heating medium.

In carrying out the method of the present invention the heat exchanger is placed in a vertical position with the tube plate 1 near the base and the tube plate is levelled to a substantially horizontal position. A measured quantity of liquid mass, calculated to give the desired thickness of solid layer is poured on to the tube plate 1 through the connection 8. The liquid is allowed to settle and level out on the tube plate and then solidified by means according to the nature of the liquid and as described above. The resultant solid layer 9 adheres to the tube plate and tubes and insulates the tube plate from contact with the cooling or heating medium.

Referring to Fig. 2 of the drawing, the tubes 2 are expanded into the tube plate 1 which is rigidly welded to the shell 3. The tube plate is attached to the liquor connecting pipe 5 by means of flange 6 welded to the pipe and bolts 7 passing through matching bolt holes in the tube plate and flange. In addition to the connection 8 for the entry or exit of the cooling or heating medium a small connection 10 is provided in the shell opposite the connection 8 so that the base of the connection 10 is nearer the tube plate than the base of the connection 8. The connection 10 is shown screwed internally so that it is closeable with a screwed plug.

With reference to the enlarged sectional view of Fig. 3, metal projections or studs 11 are welded to the inner surface of the shell 3 at suitable points along the circumference and close to the tube plate.

With the heat exchanger in a vertical position and the tube plate 1 at or near the base and levelled to a truly horizontal position, the liquid heat insulating material is poured on to the tube plate 1 through the connection 8 until it overflows through the connection 10. The connection 10 is then wiped free from any adhering liquid and the liquid is allowed to level out on the tube plate. The metal studs are immersed in the liquid. The liquid is solidified by means according to the nature of the liquid and as described above and the resultant solid insulating layer 9, which adheres to the tube plate and tubes, has embedded in it the studs 11. These embedded studs serve to key the solid layer 9 to the inner surface of the shell 3.

What we claim is:—

1. A method of insulating a tube plate of a multi-tubular heat exchanger having a shell surrounding the tubes which comprises the steps of positioning the exchanger to bring said tube plate lowermost and substantially horizontal, pouring a settable heat insulating material through an aperture in the shell of the exchanger, and thereafter allowing the material to settle and solidify with or without the application of heat as necessary, to form a heat insulating layer in contact with the tube plate and the adjacent end regions of the exchanger tubes.

2. The method of claim 1 in which the material is introduced into the shell through an aperture normally adapted for conveying a cooling or heating medium into or out of the shell wherein it will be in heat exchange relationship with the tubes.

3. The method of claim 1 or 2 in which a quantity of the material is used which is calculated to give the desired thickness of said insulating layer.

4. The method of claim 1 or 2 in which the material is poured into the shell until it flows out of an overflow aperture suitably disposed near to the tube plate so as to provide for the required thickness of said insulating layer and disposed between the plate and the pouring aperture.

5. The method of any preceding claim which includes the step of attaching by welding or like means a plurality of projections to the inner face of the heat exchanger shell close to the tube plate, prior to assembly of the heat exchanger, whereby to key to the shell the heat insulating layer subsequently deposited and allowed to solidify.

6. A method according to any preceding claim in which the pourable heat insulating material comprises the liquid form of a thermosetting resin which after settling on the tube plate is hardened out by the application of heat.

7. A method according to any of claims 1 to 5 in which the pourable heat insulating material comprises the liquid form of a thermosetting resin mixed with a hardening catalyst which after settling on the tube plate hardens out on standing with or without the application of heat.

8. A method according to any of claims 1 to 5 in which the pourable heat insulating material comprises hot molten resin, wax, pitch or bituminous material which after settling on the tube plate is hardened to a solid layer by cooling.

9. A method according to any of claims 1 to 5 in which the pourable heat insulating material comprises a solution of a natural or synthetic resin or thermoplastic material, such as natural or synthetic rubber, in a solvent and after settling on the tube plate the solvent is evaporated by the application of heat to leave a residue in the form of a solid insulating layer.

10. A method according to any of claims 6 to 9 in which a filler of powered inorganic material is intimately mixed with the heat insulating material to a uniform suspension before pouring onto the tube plate.

11. A method according to any of claims 1 to 5 in which the pourable heat insulating material comprises a plaster or cement slurry, with or without the addition of aggregate, and after the slurry has settled on the tube plate it is hardened to a solid layer on standing.

12. A method of insulating a tube plate of a multi-tubular heat exchanger substantially as herein particularly described with reference to the accompanying drawings.

13. A multi-tubular heat exchanger having a heat insulating layer on the tube plate applied by the method claimed in any of the preceding claims.

W. P. THOMPSON & CO.,
12, Church Street, Liverpool, 1,
Chartered Patent Agents.

Leamington Spa: Printed for Her Majesty's Stationery Office, by the Courier Press.—1957.
Published at The Patent Office, 25, Southampton Buildings, London, W.C.2, from which copies may be obtained.

D3

776,416 **COMPLETE SPECIFICATION**
1 SHEET

This drawing is a reproduction of the Original on a reduced scale.

Wärmetauscher (zur Eindickung einer Lösung) — kein Reaktor! —

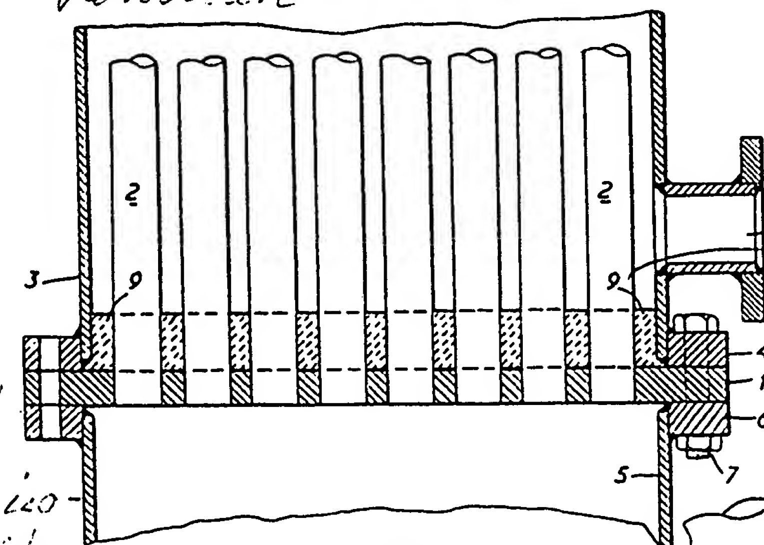

FIG. 1

isolier...

Rohrboden

an sich

über gießbare feste Wärmeisolationsschichten mit ... 200°C

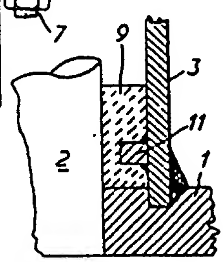

FIG. 3

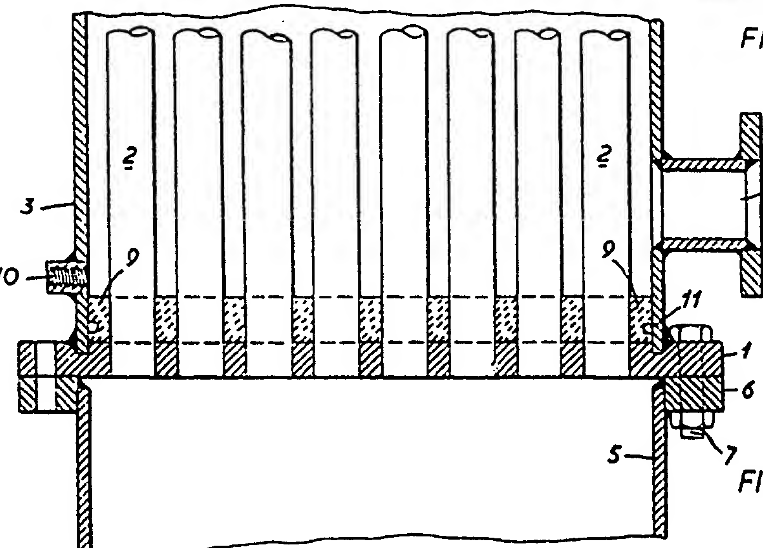

FIG. 2

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